How do we learn about the origin of herps?

- Study relationships among living species
- Find and analyze fossils
- Understand genetics and development

Things you might think about the transition to land

Legs evolved for locomotion on land

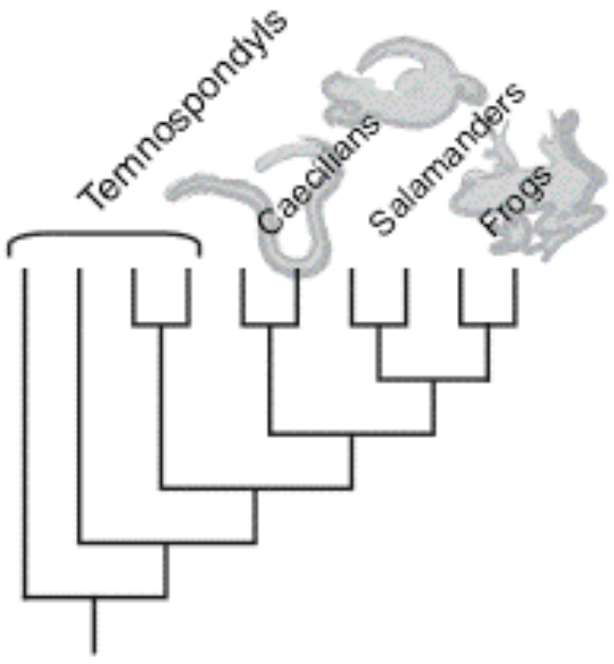
Lungs evolved for breathing on land

Acanthostega

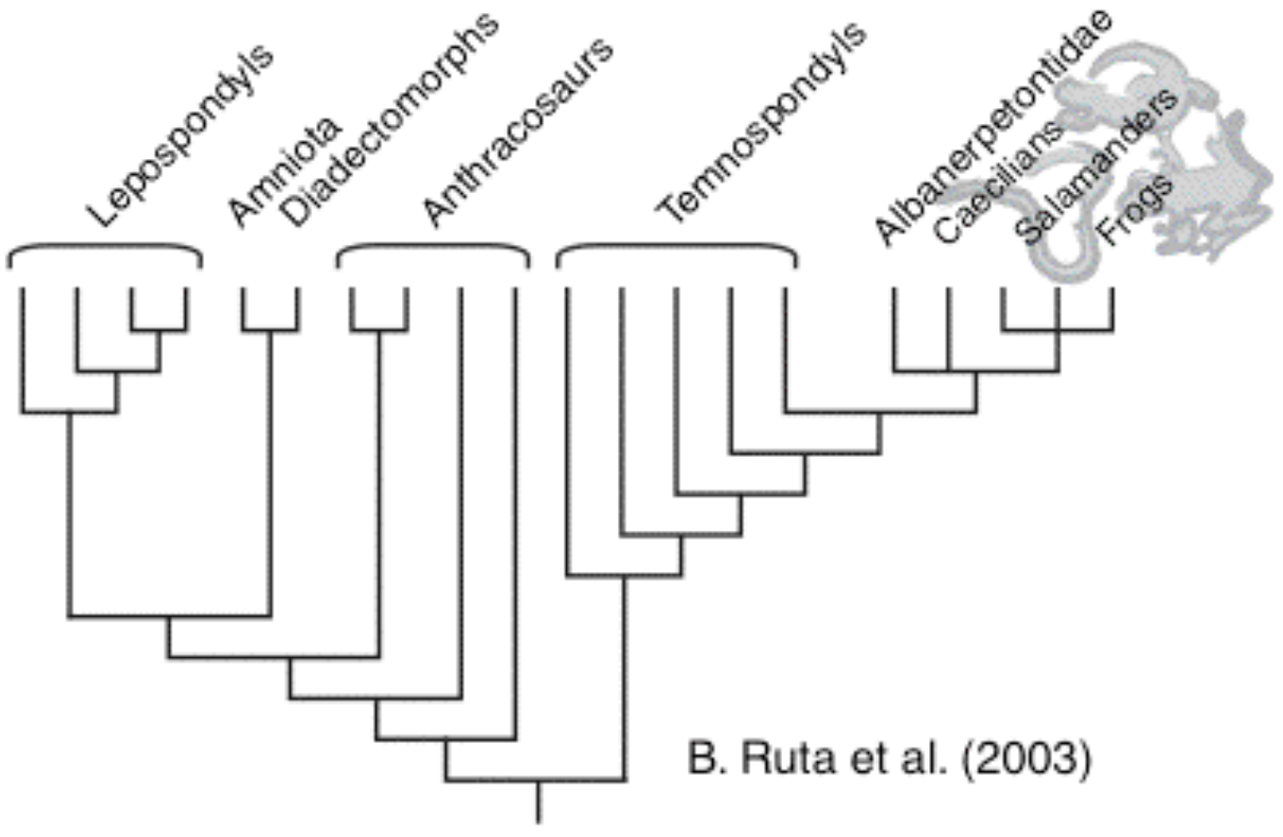
– 365 mya
– Best-known early tetrapod
– Limbs with 8 digits
– Aquatic

Ichthyostega

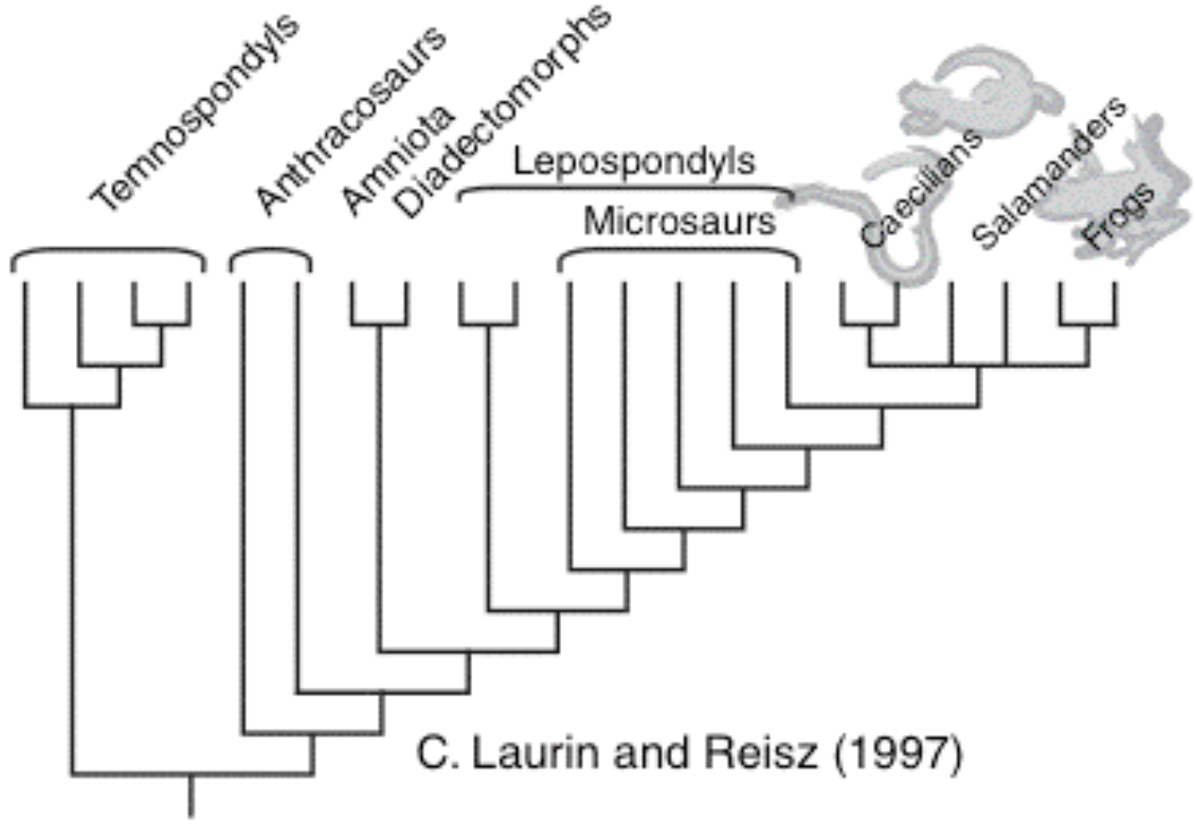
- 365 mya
- Limbs with 7 digits
- Fish-like tail but likely some ability to move on land



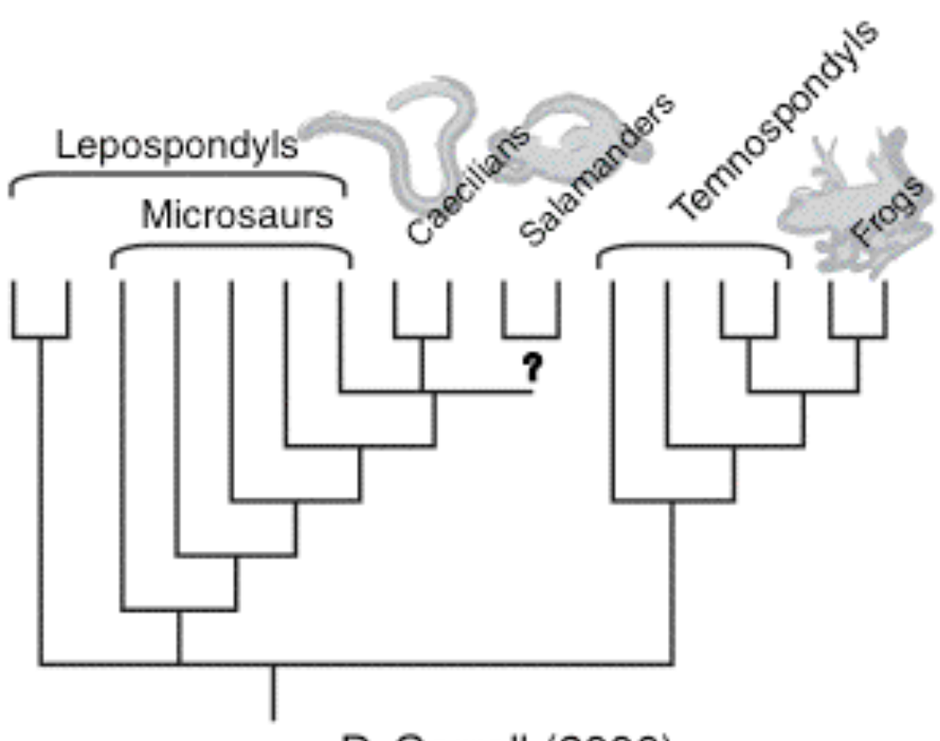
A. Trueb and Cloutier (1991)



B. Ruta et al. (2003)



C. Laurin and Reisz (1997)



D. Carroll (2000)

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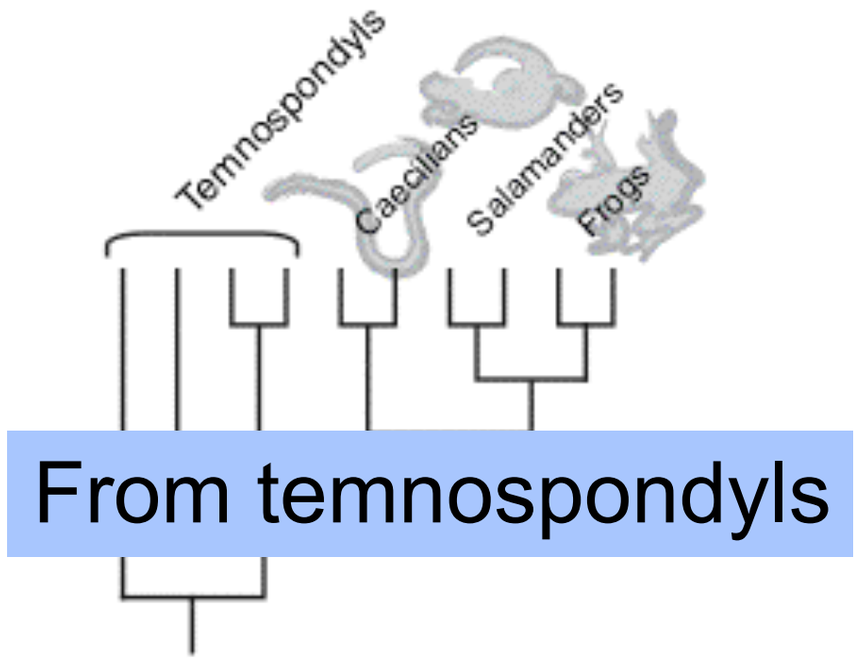

From temnospondyls

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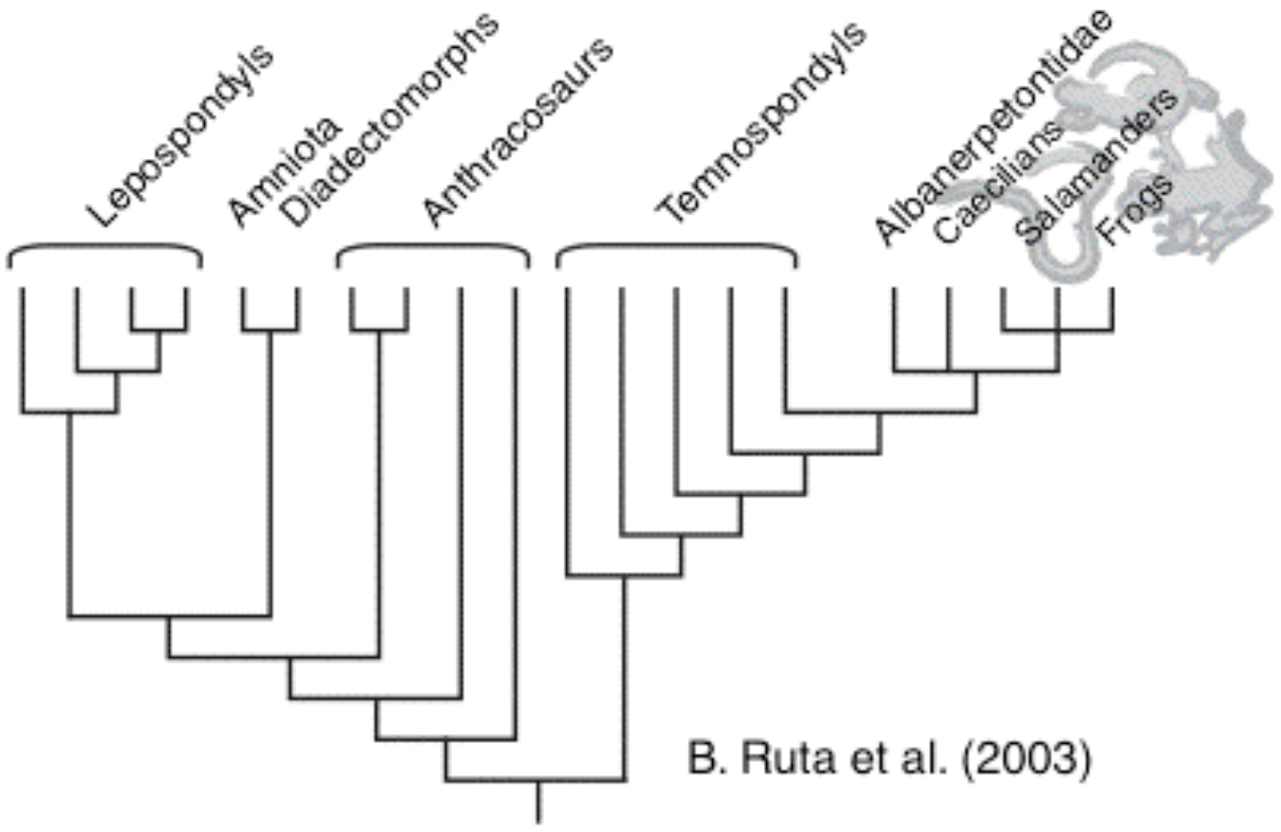

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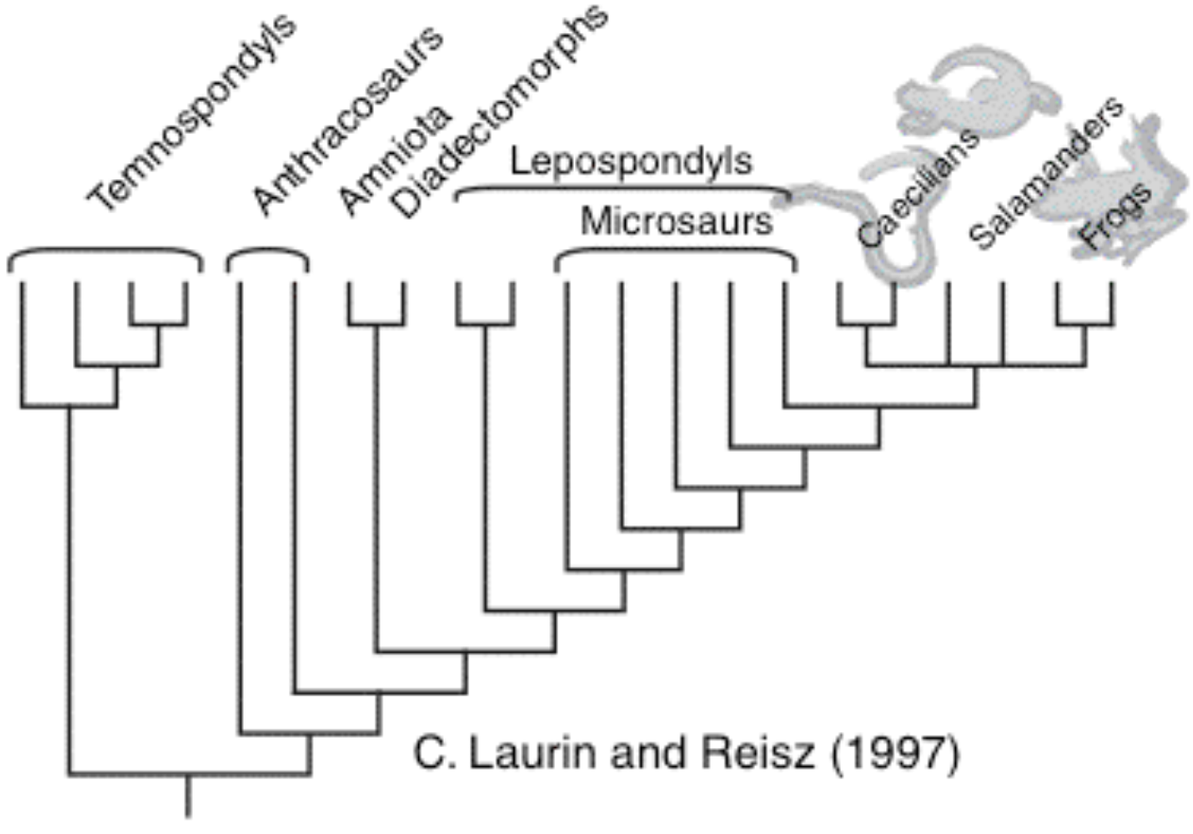

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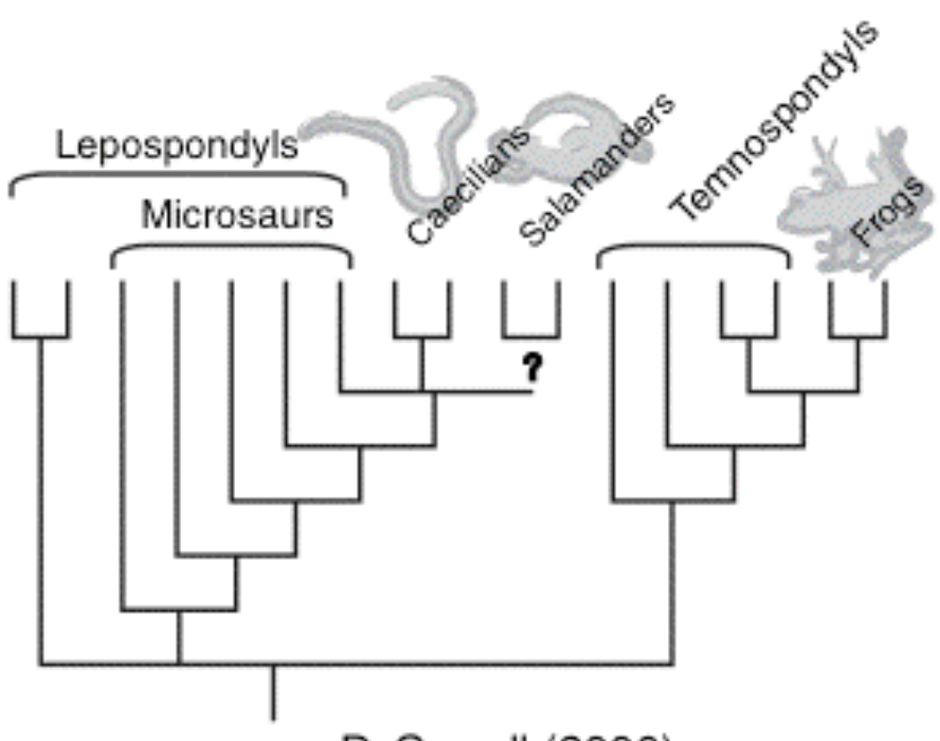

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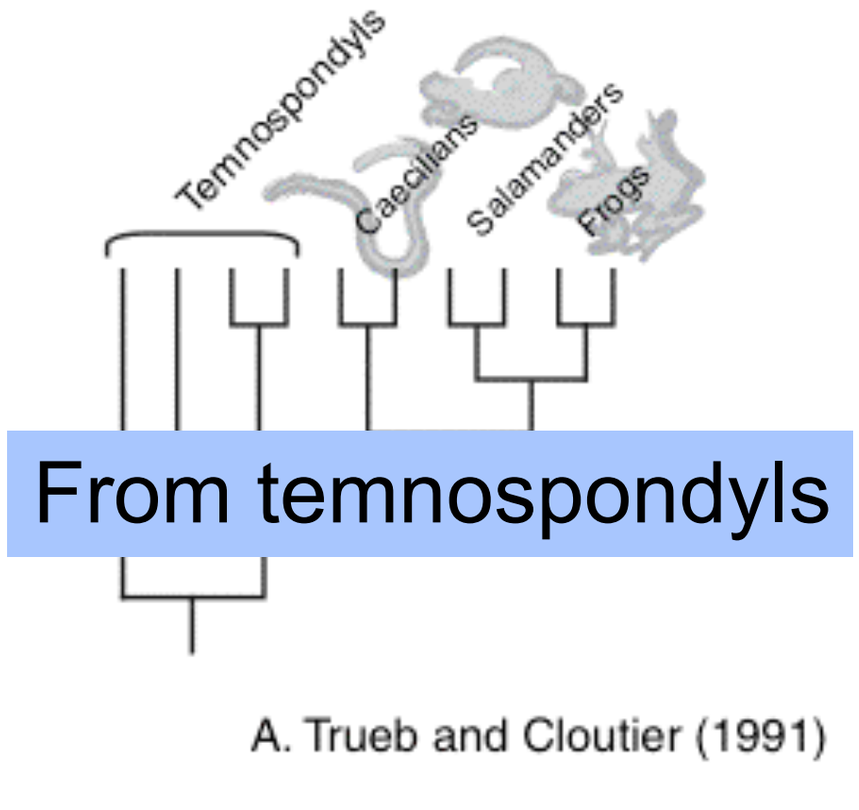

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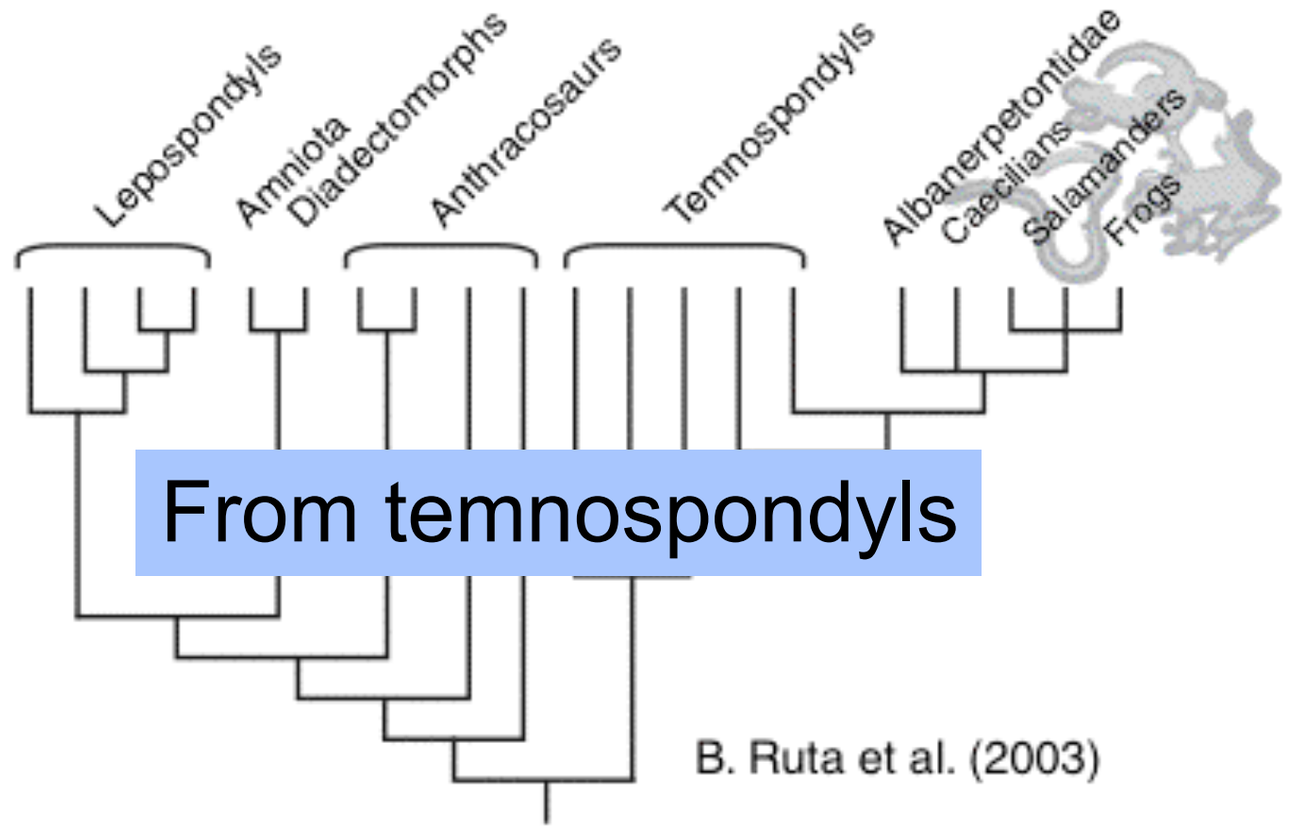

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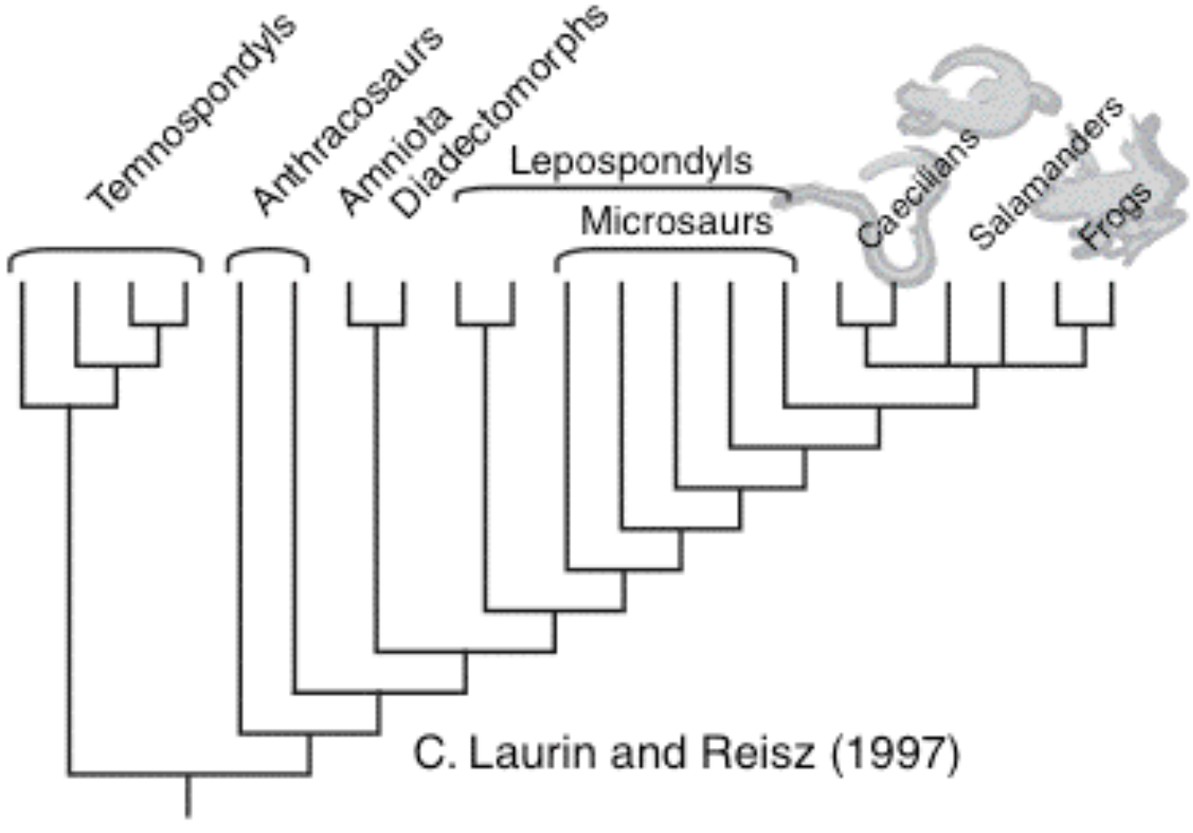

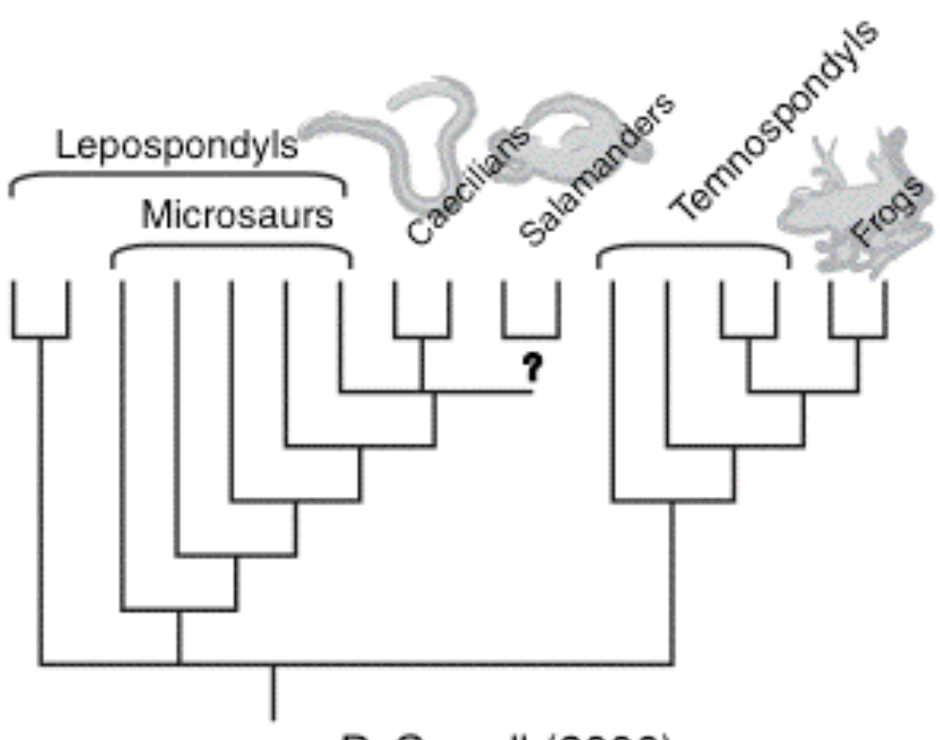

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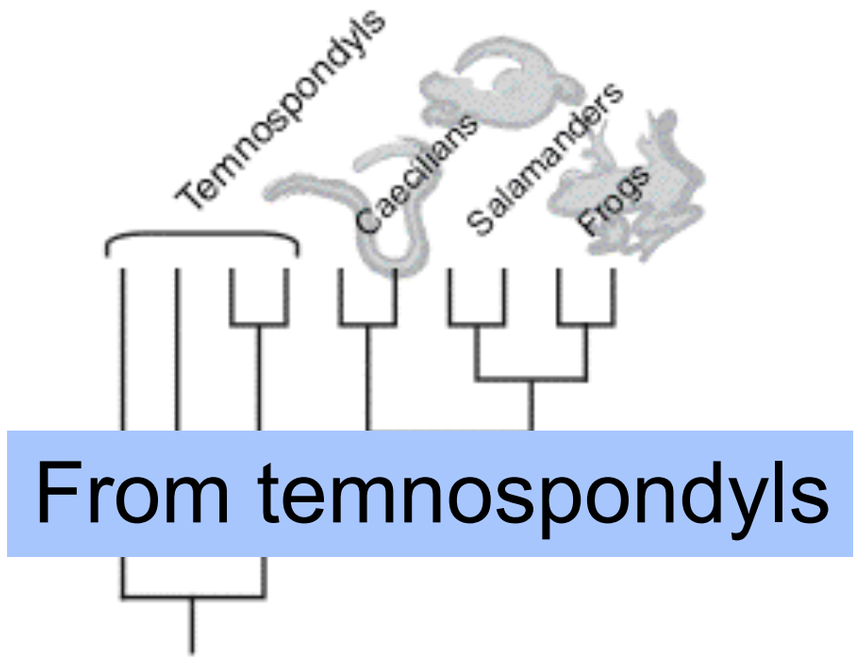

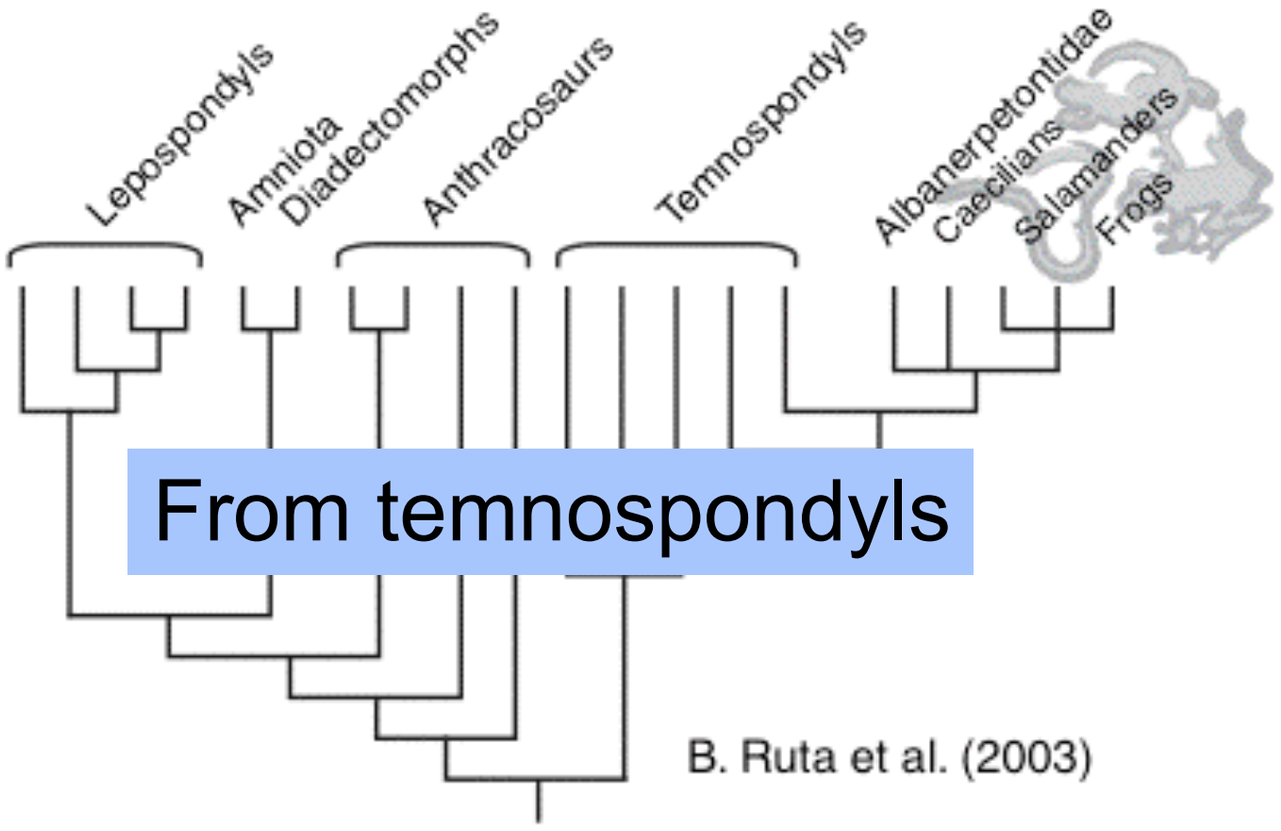

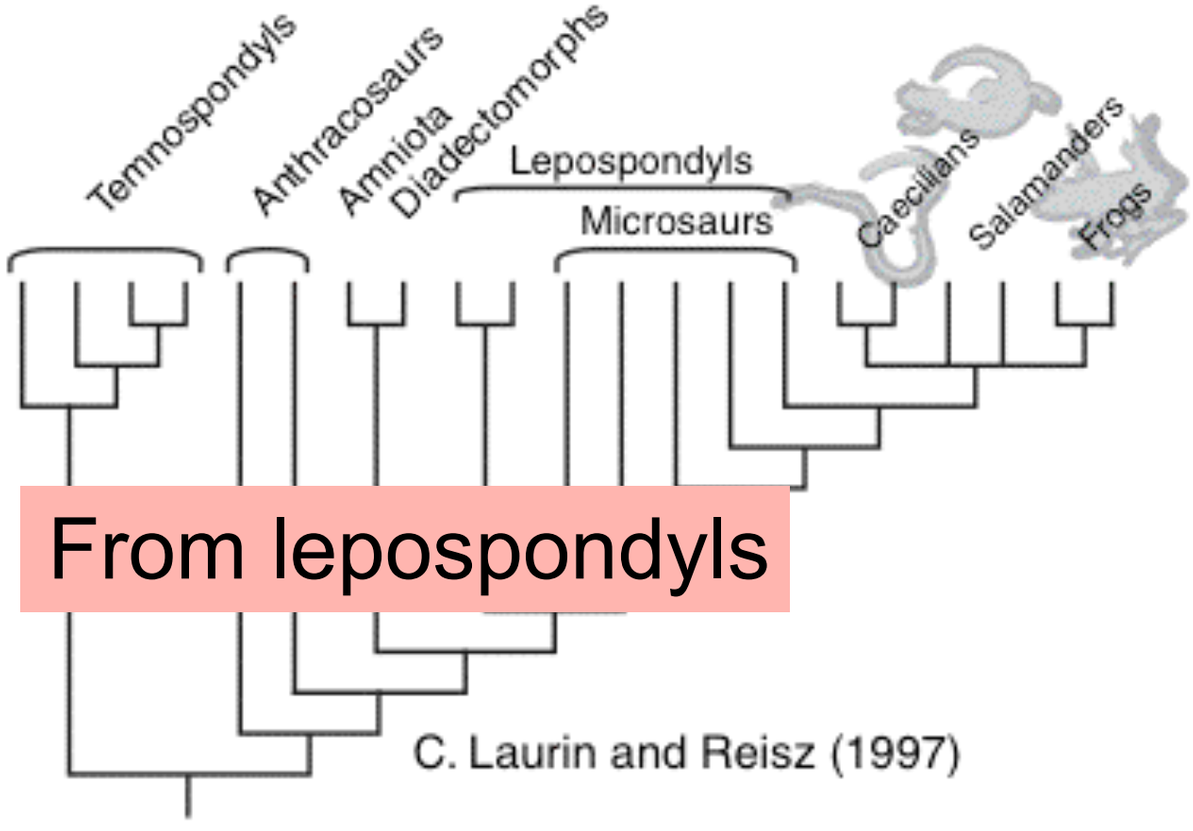

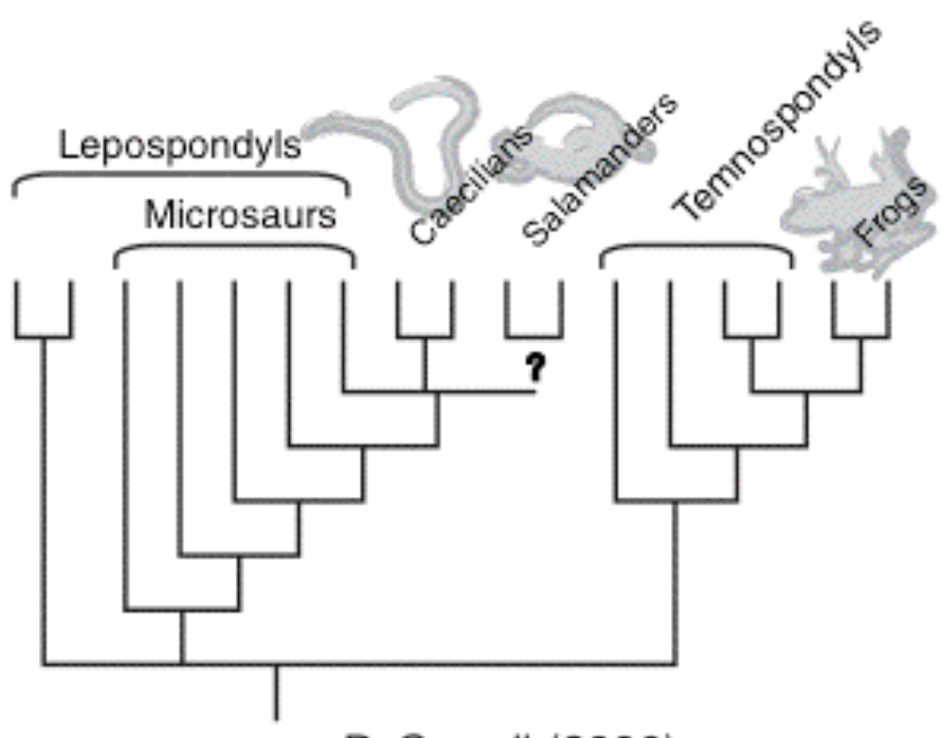

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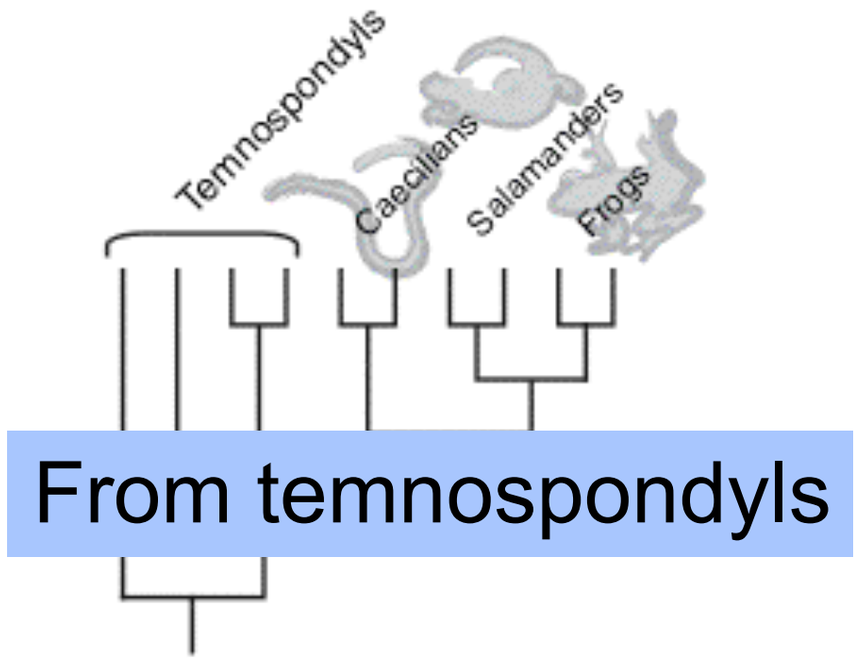

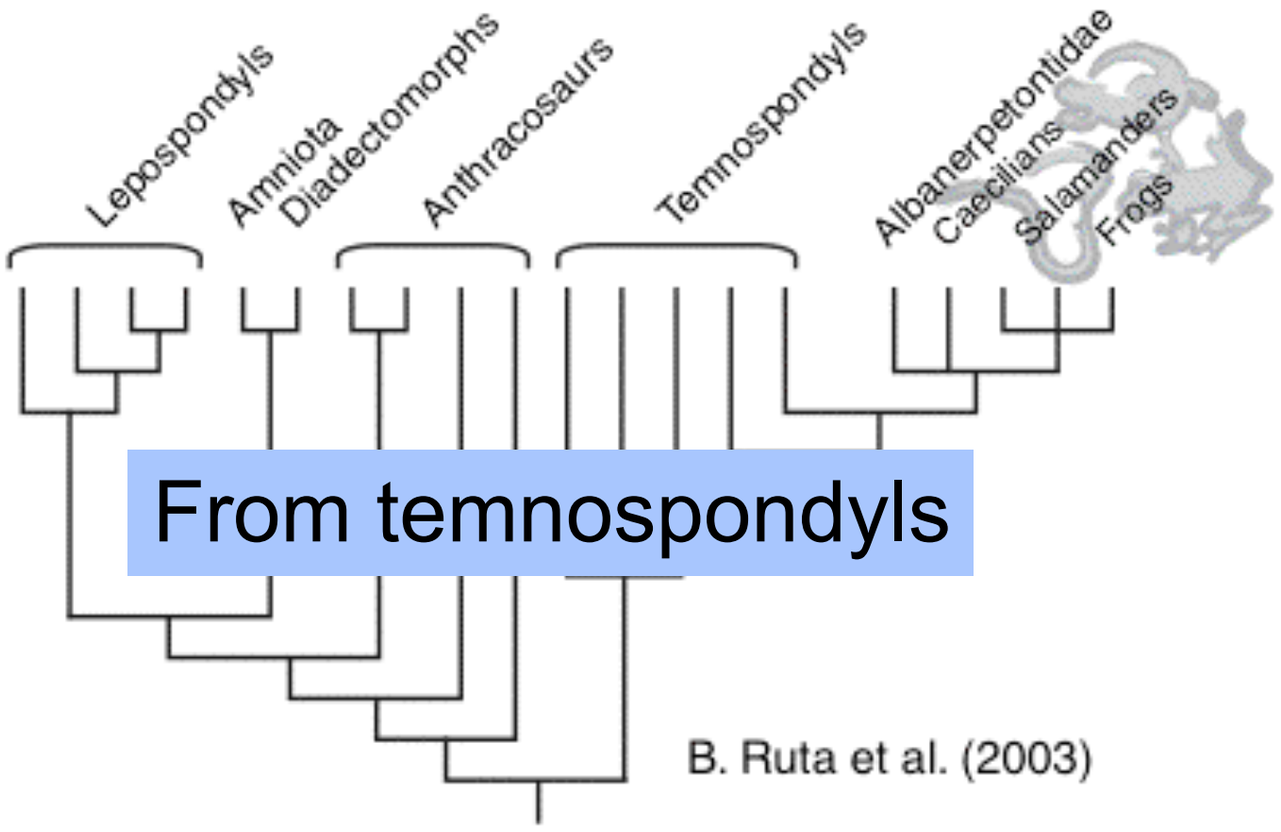

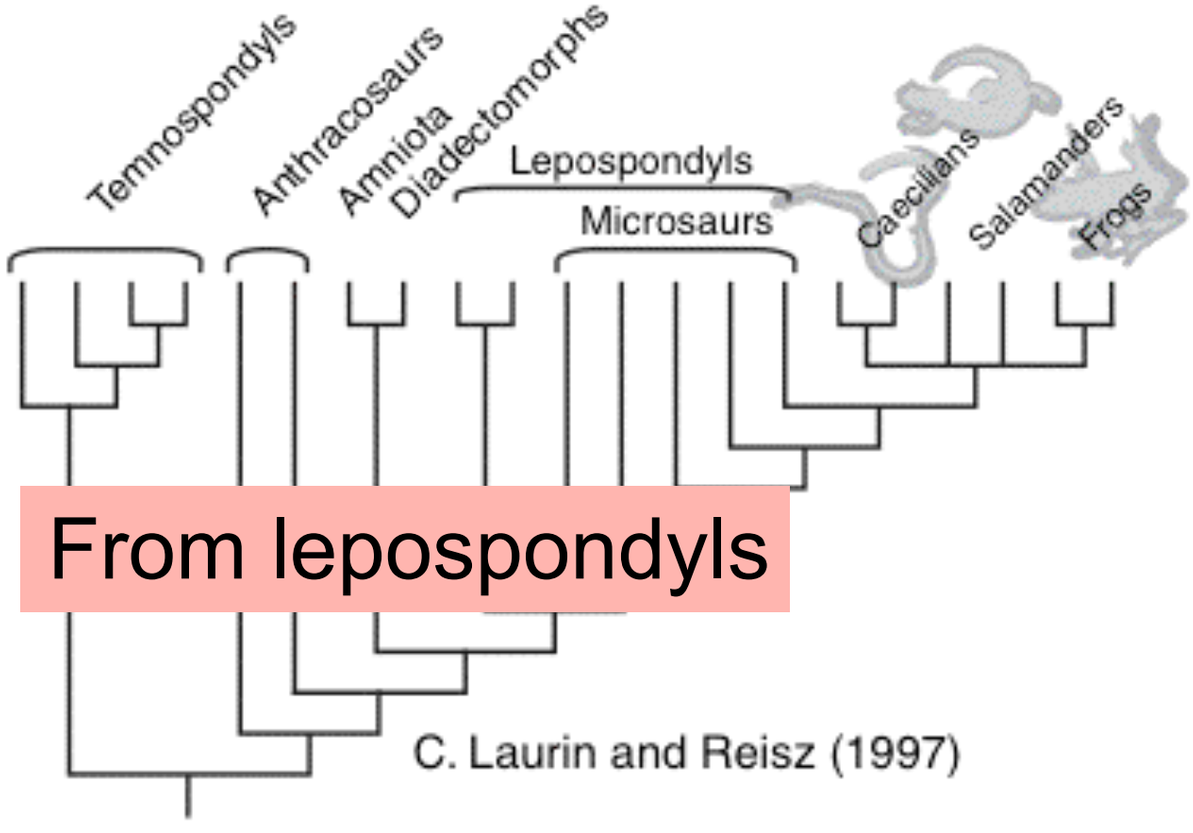

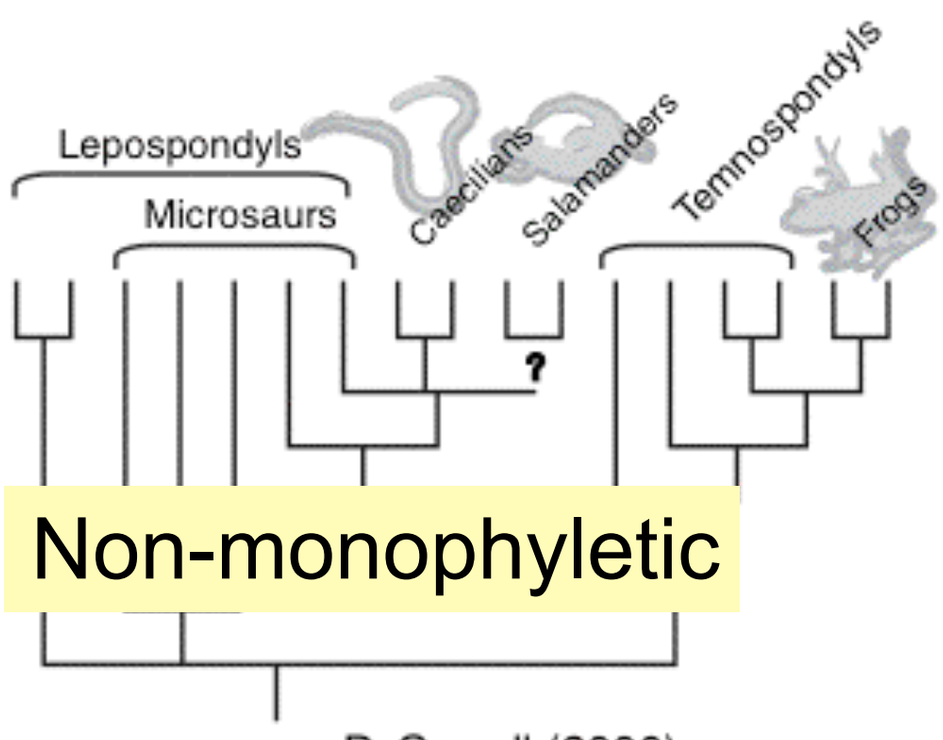

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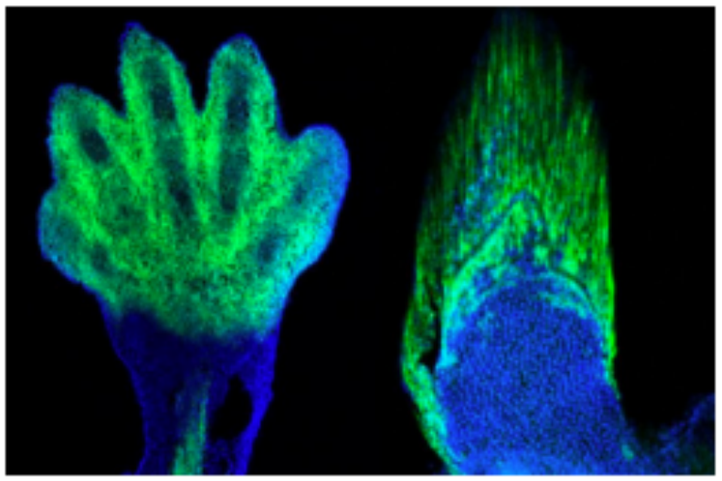
The New York Times

Science

CRAIG COOK/UNDERSEA MEDICAL

Giant Coral Reef in Protected Area Shows New Signs of Life



MARIE KMITA AND ANDREW GEHRKE

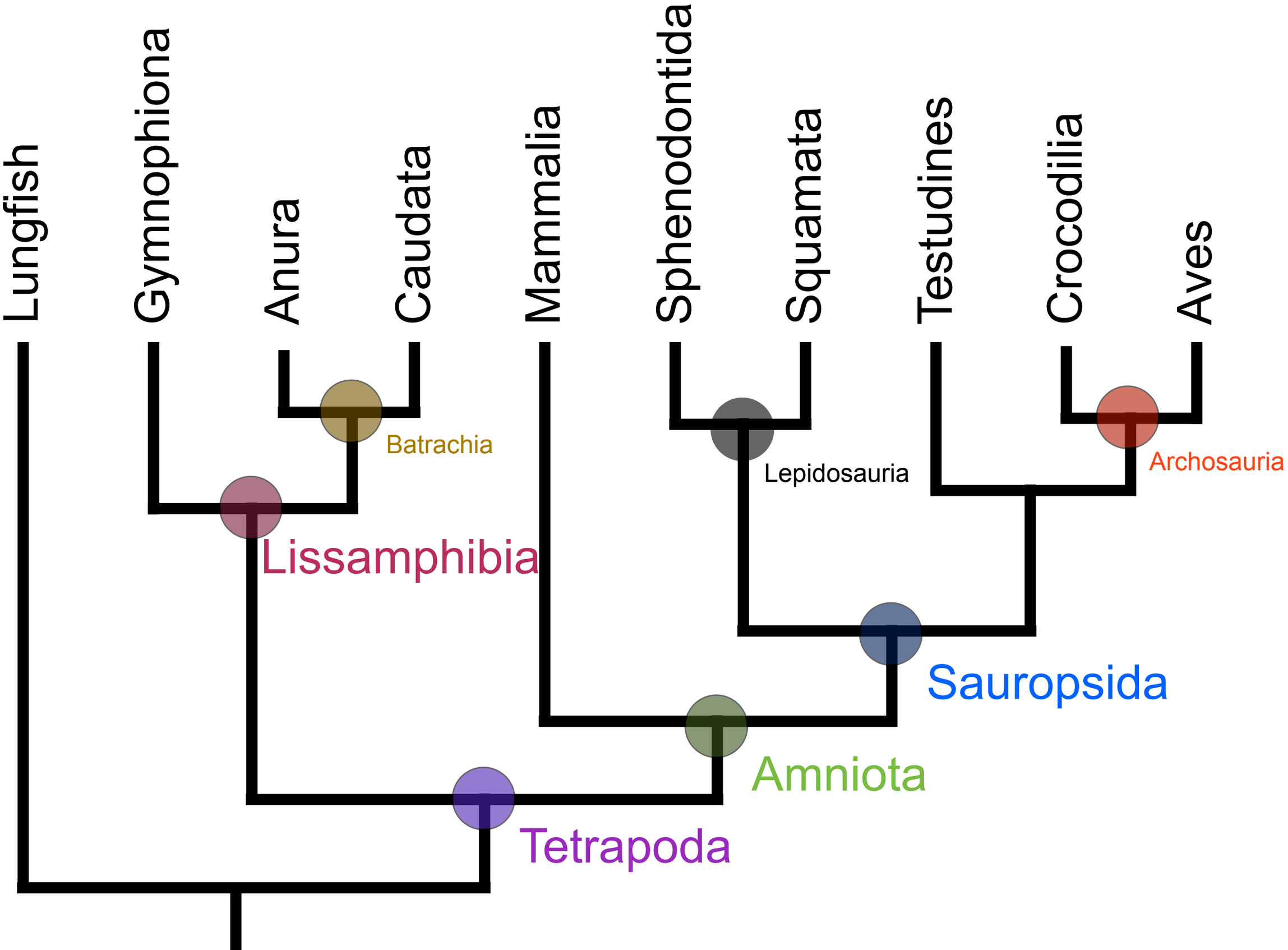
MATTER

From Fins Into Hands: Scientists Discover a Deep Evolutionary Link

The findings by a University of Chicago team will help researchers understand how our ancestors left the water, transforming fins into limbs so they could move on land.

1d ago · By CARL ZIMMER

Systematics of living “herps”



Biogeography and Phylogeography

- **Biogeography** is the study of historical processes that affect the geographic distributions of animal and plant species
- **Phylogeography** is the study of historical processes that affect the geographic distribution of genetic variation within species

Main Biogeographic Explanations

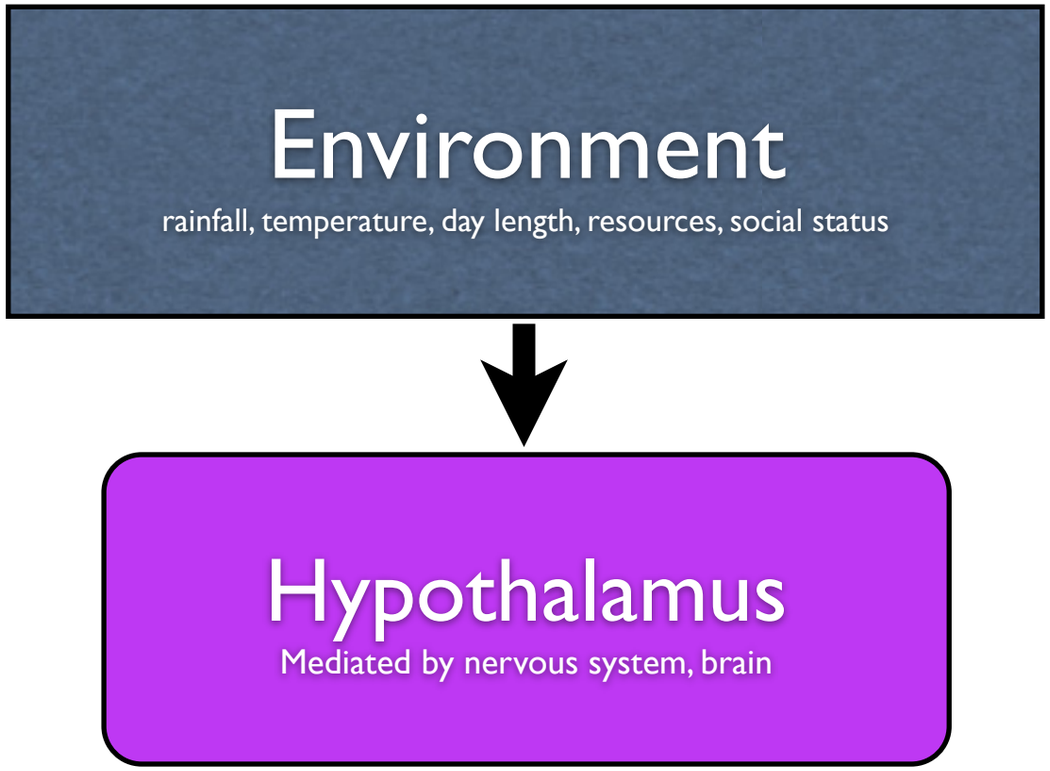
- Vicariance: species ranges are explained by splitting due to the formation of barriers
- Dispersal: species ranges are explained by movements (dispersal) into new areas

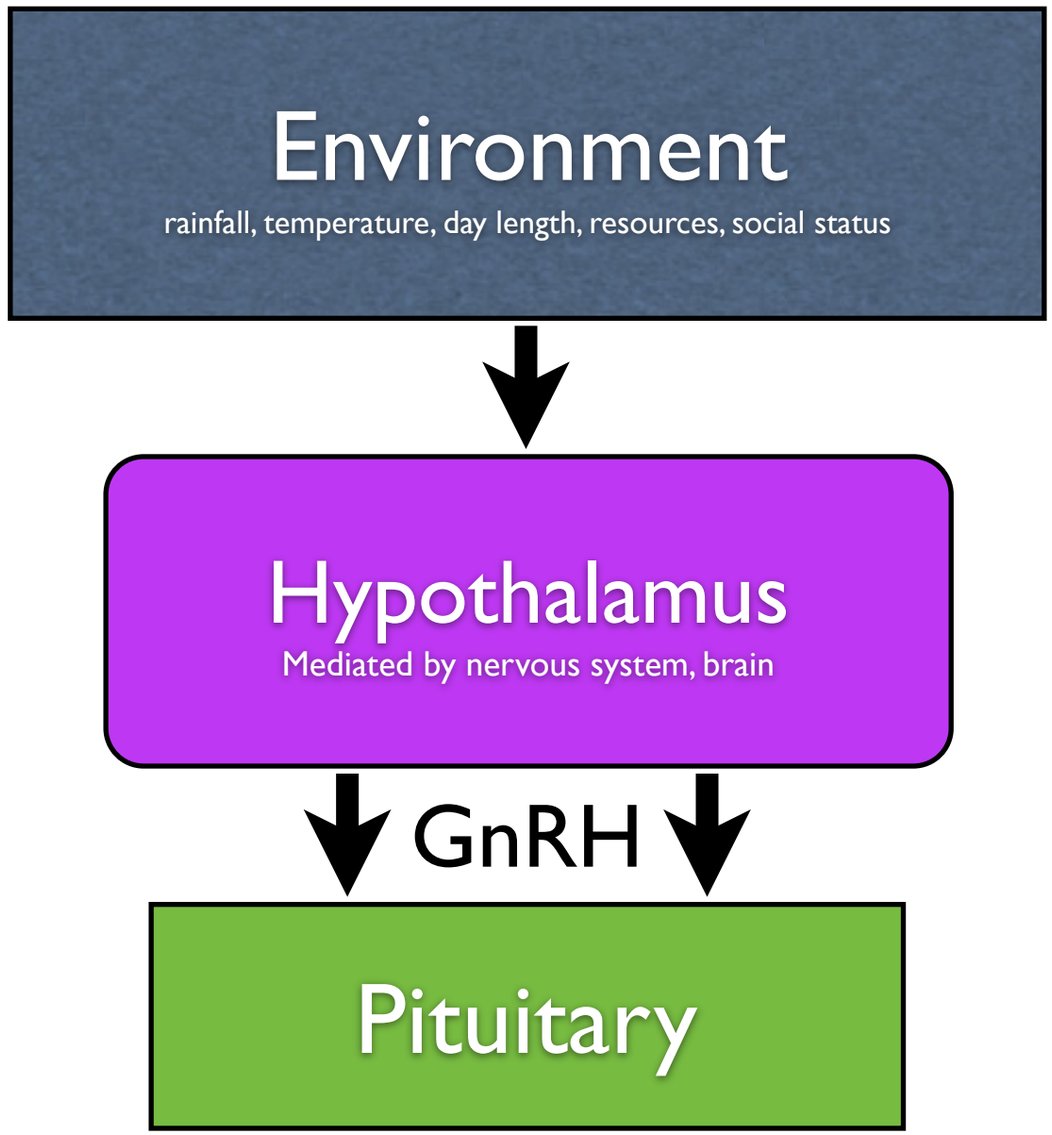
Reproduction

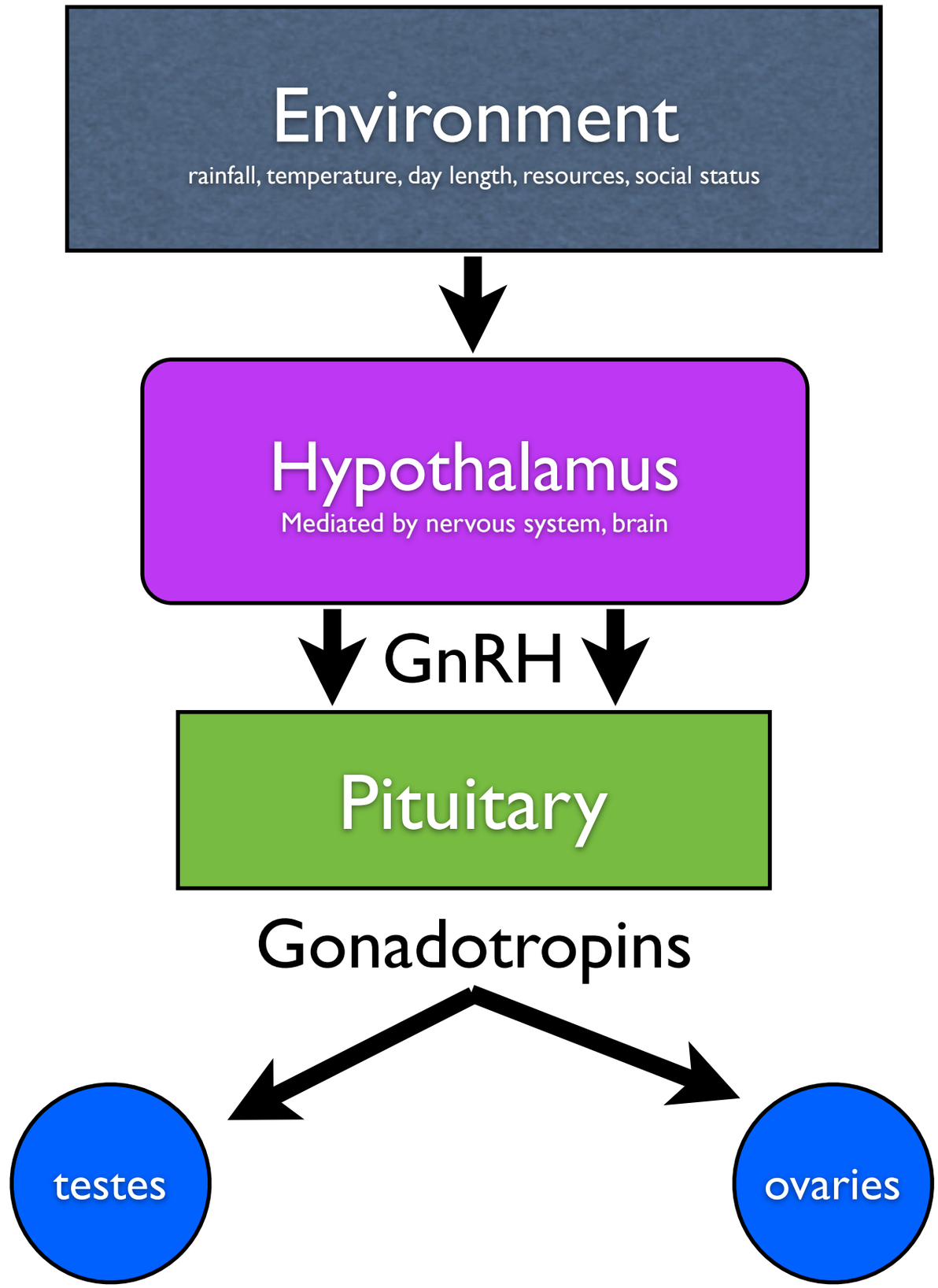
- **Egg to zygote:** How do eggs get fertilized?
- **Zygote to juvenile**: What are the different herp reproductive modes?

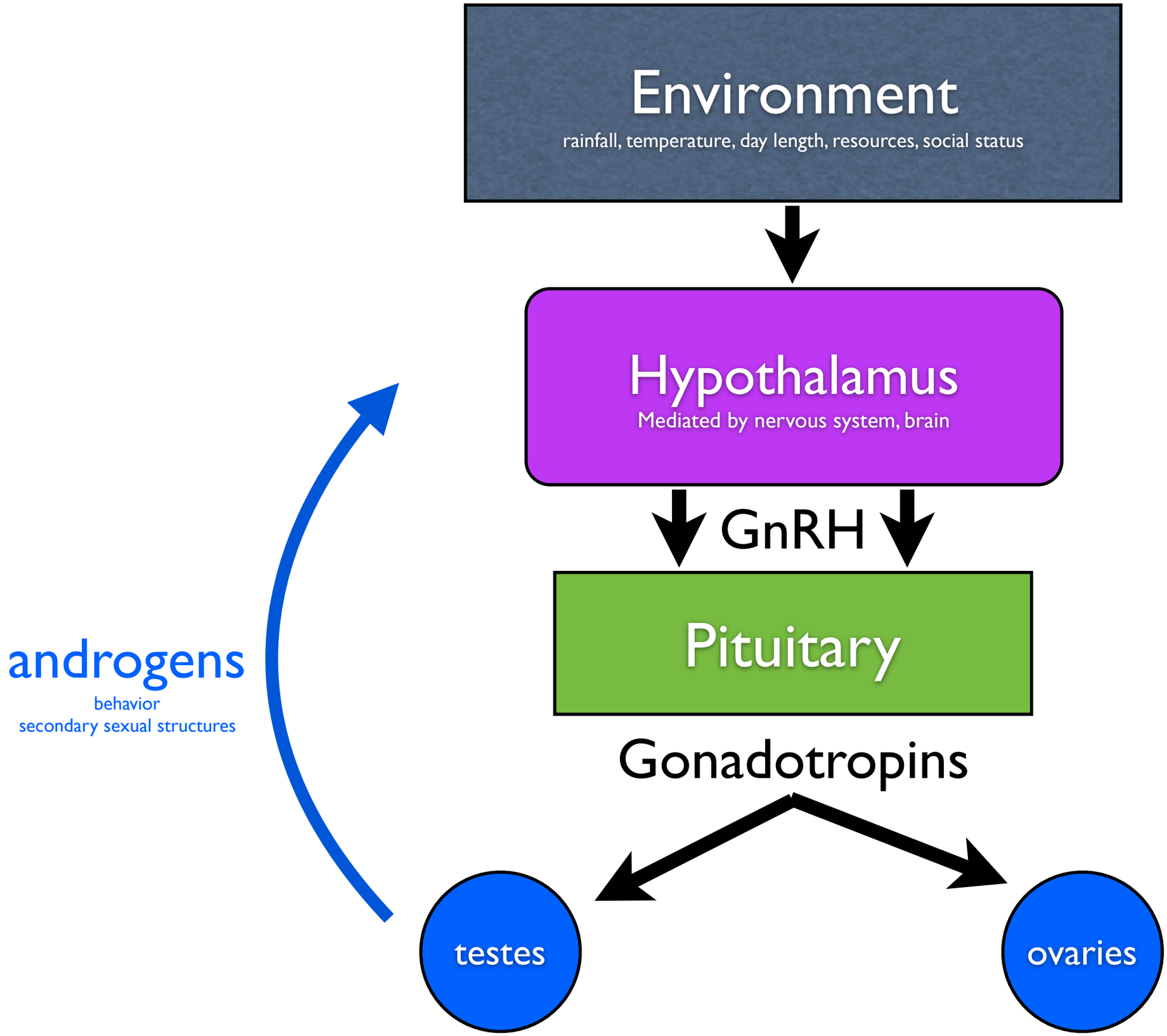
Environment

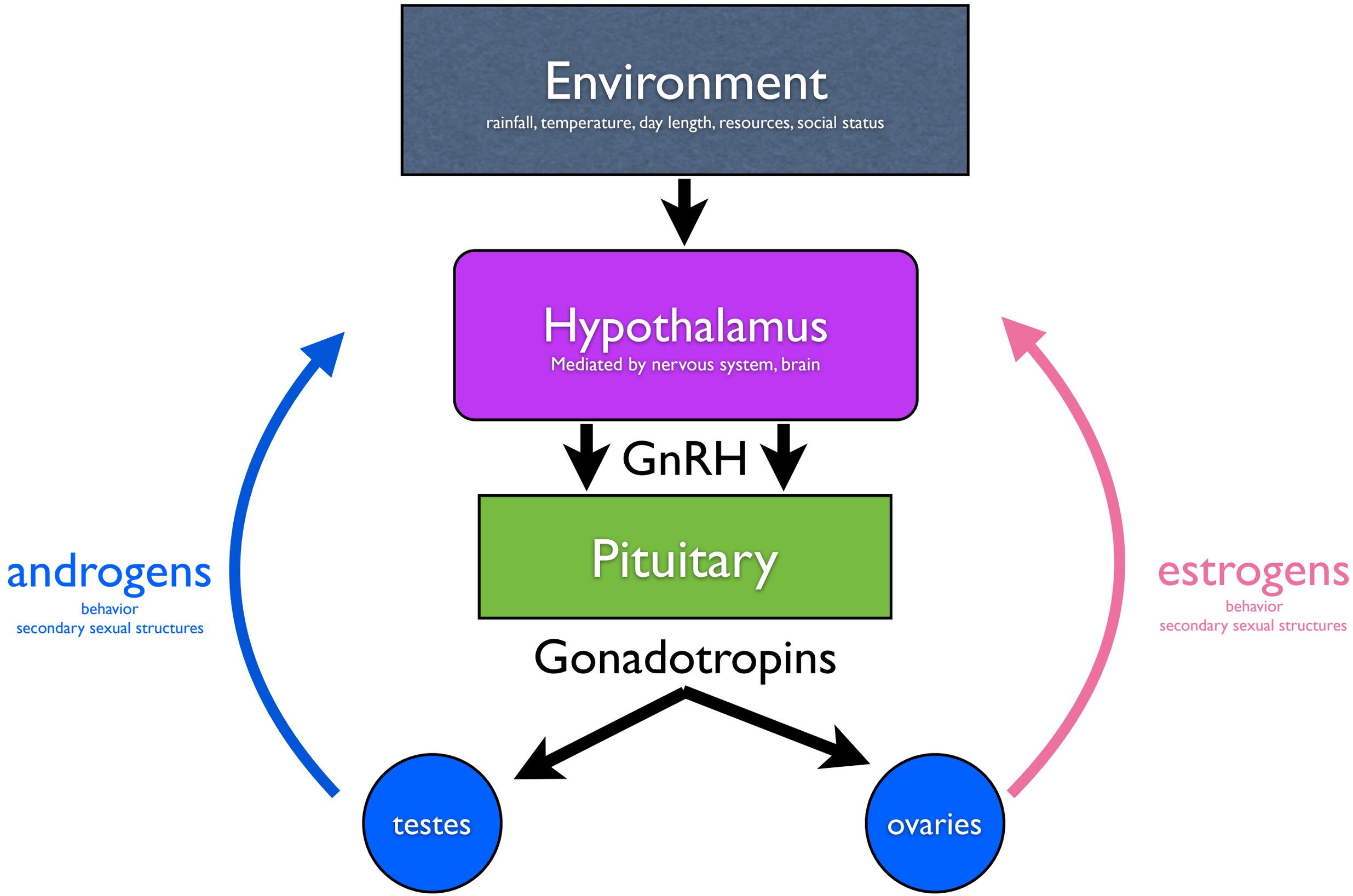
rainfall, temperature, day length, resources, social status


Environment
rainfall, temperature, day length, resources, social status
Hypothalamus
Mediated by nervous system, brain


Environment
rainfall, temperature, day length, resources, social status
Hypothalamus
Mediated by nervous system, brain
GnRH
Pituitary


Environment
rainfall, temperature, day length, resources, social status
Hypothalamus
Mediated by nervous system, brain
GnRH
Pituitary
Gonadotropins
testes
ovaries


Environment
rainfall, temperature, day length, resources, social status
Hypothalamus
Mediated by nervous system, brain
GnRH
Pituitary
Gonadotropins
testes
ovaries
androgens
behavior
secondary sexual structures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Hypothalamus
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GnRH
Pituitary
Gonadotropins
testes
ovaries
androgens
behavior
secondary sexual structures
estrogens
behavior
secondary sexual structures

Internal vs. External Fertilization

- **Internal fertilization** occurs inside the females body
- Found in all caecilians, most salamanders, two frogs, and all reptiles (and mammals)
- Requires a way to get sperm inside the female's body

Amphibian nesting

- Amphibians show a wide variety
- Many lay jelly-covered eggs in an aquatic habitat
- But, there are other possibilities…

Growth and Development

- Sex determination
- Development: embryogenesis and morphogenesis
- Metamorphosis

Asexual Reproduction

- Most species of reptile and amphibian undergo "normal" sexual reproduction
- At least 50 species undergo unisexual reproduction
- Includes salamanders, frogs, and squamates

ZZ

ZW

ZZ

ZZW

ZZ

ZWW

XY

XX

XO

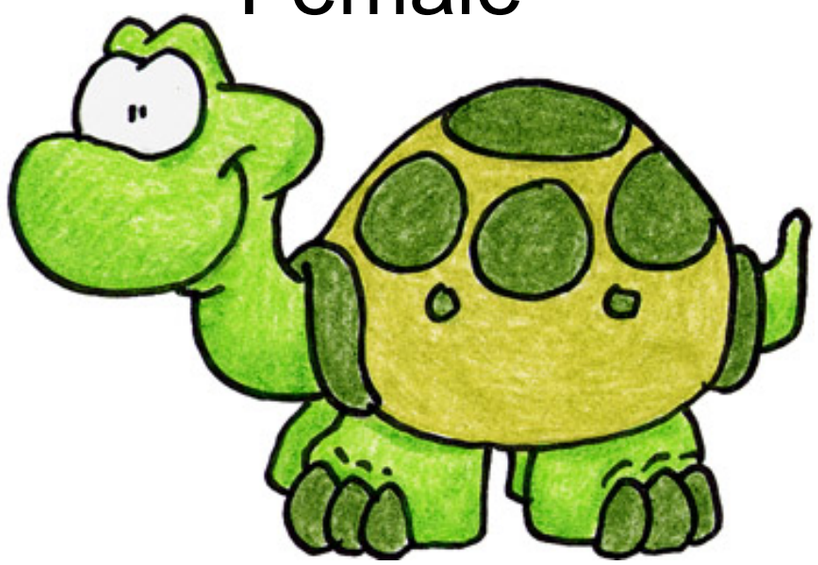
XX

XXY

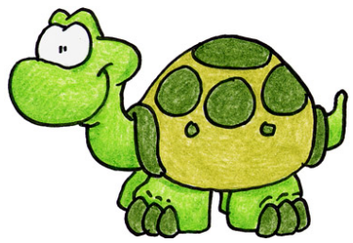
XX

Why TSD?

Female



Male



Embryogenesis

- The formation of the embryo through metamorphosis, hatching, or birth
- Dramatically different between reptiles and amphibians

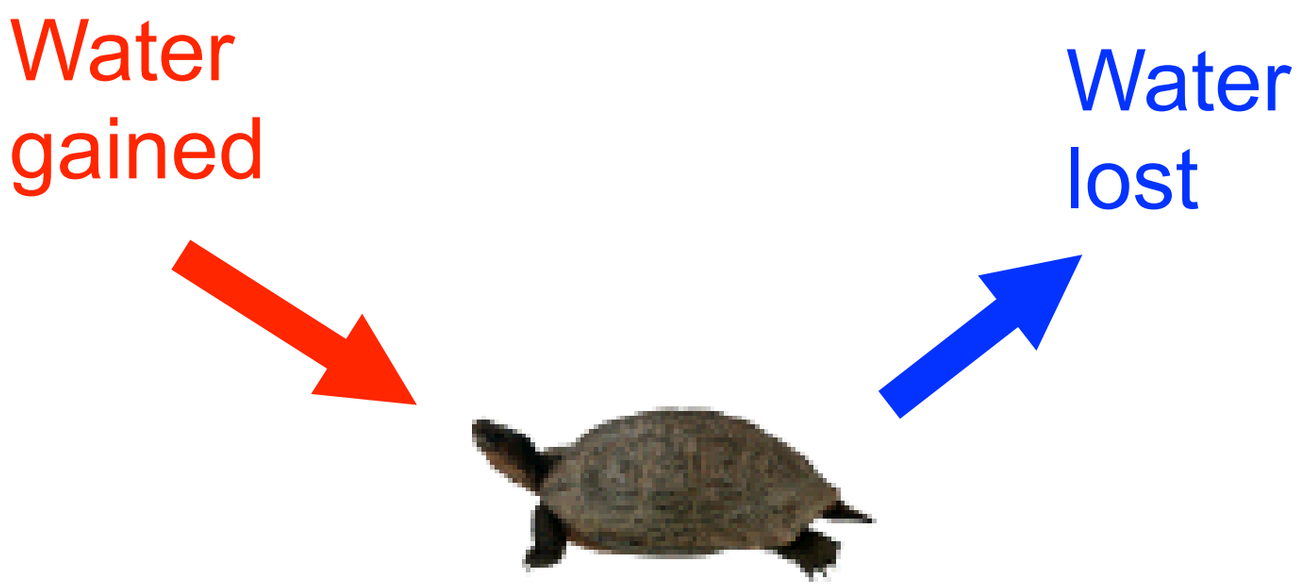
salamander egg

hatching turtle

Patterns of Heterochrony

- **Paedomorphosis** occurs when a trait fails to develop to the extent observed in related species
- In paedomorphic species one can observe larval traits in otherwise "adult" individuals

Water balance



At water balance:

Water gained = Water lost

Taking in water

liquid water

preformed water

metabolic water

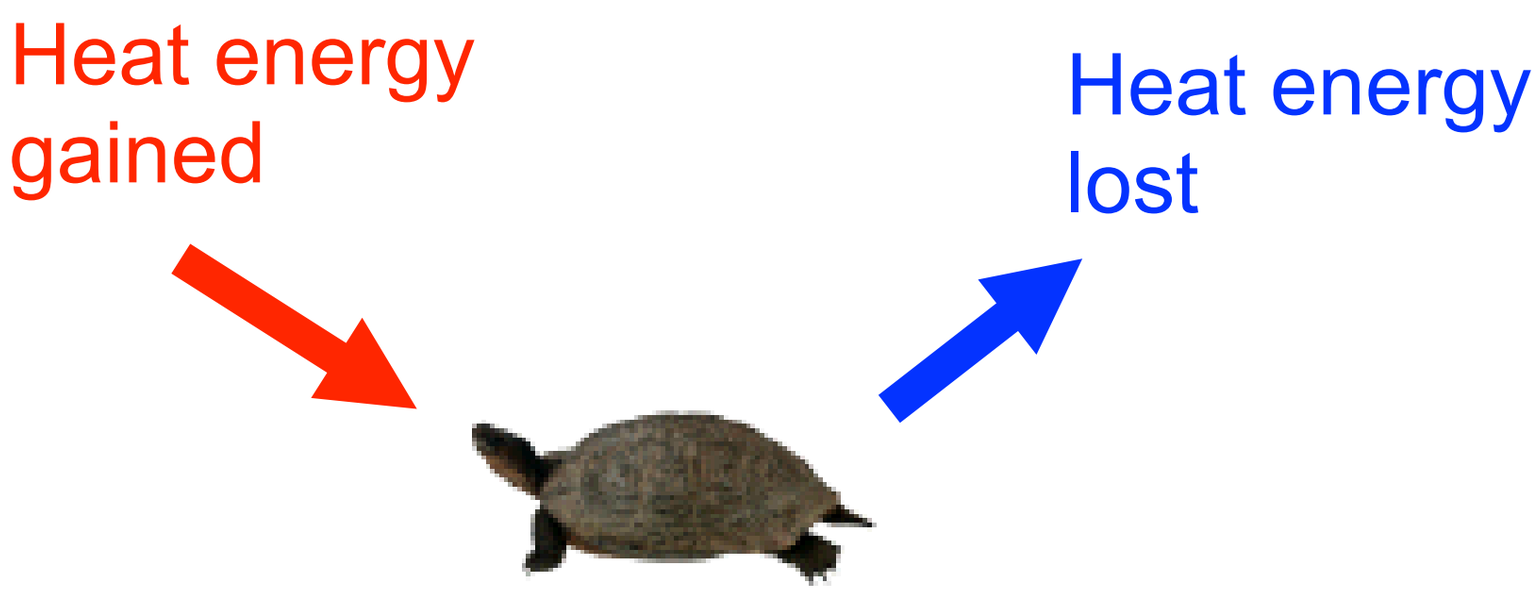
Losing water

evaporation

urine and feces

salt glands

Heat Transfer in Animals



At thermal equilibrium:

Heat energy gained = Heat energy lost

Heat transfer in animals

solar radiation

metabolic heat

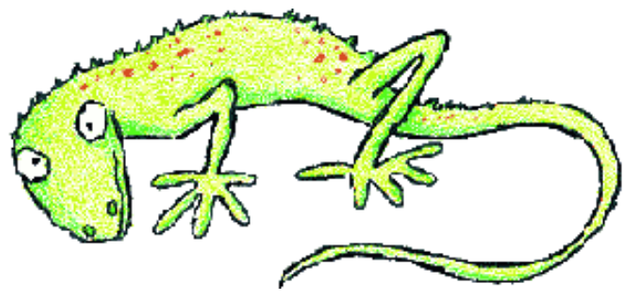
infrared

convection

condensation/ evaporation

conduction

COOL



HOT

Amphibian life-history strategies

- (Most) amphibians metamorphose, so their life-history patterns are complex
- Different life stages typically face different threats and have different levels of mortality
- Lots of variation in clutch size, reproductive timing, and life span

Reptile life-history strategies

- Crocodylians and turtles are long-lived, late maturing, and reproduce over many years
- Squamates vary from short-lived with high reproductive investment (e.g. *Uta*) to long-lived with small broods (e.g. *Cyclura*)
- Species have single vs. multiple broods, early versus late maturity